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ABSTRACT

California faces a severe nursing shortage, with the number of registered nurses far below what is required to avert a potential state health care crisis. The Associate Degree Nursing (ADN) Project is a joint project involving scholars, educational researchers, and analysts from the Center for Student Success (CSS) housed at City College of San Francisco. A team of experts from CSS has been assembled to work closely with the ADN consortium of community college nursing directors and the Chancellor's Office of the California Community Colleges (COCCC) Economic Development Program's Health Care Initiative, to develop, conduct, analyze, and disseminate findings of the proposed research project. Using data obtained from the 20 ADN consortium colleges, five cohorts of all students (5,007) who enrolled in the nursing programs during the academic years of 1994-95 through 1998-99 were studied longitudinally to determine progress and performance. The data were used to construct a model that explains variance and predicts successful program completion for ADN students by examining the dispositional and institutional characteristics of the sample. Female students were somewhat more successful than males (78% vs. 70%), students with English as a primary language were somewhat more successful (78% vs. 65%), and students age 20-44 were the most successful of all age groups. Contains 43 references. (Author/NB)

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Associate Degree Nursing:

Model Prerequisites Validation Study

California Community College

Associate Degree Nursing Programs

By

The Center for Student Success

A Health Care Initiative Sponsored Project

June, 2002

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Executive Summary

Associate Degree Nursing Project (ADN) Report

Health care providers from throughout California have been voicing concern about the lack of qualified registered nurses (RN's) to meet the state's growing health care needs. Although there are several reasons for this shortage that are beyond the control of the community colleges such as competitive labor markets, wages and working conditions, and training costs, health care experts also cite a relatively high attrition rate among nursing program students as an important contributing factor. Attrition in nursing programs is believed by many Associate Degree Nursing (ADN) faculty to be related to the lack of required core prerequisites and skill levels for entry into ADN programs. In addition, inconsistency over the identification and application of required prerequisite courses across college programs has hampered attempts to create a core of prerequisite courses that would be consistently applied when selecting students into college ADN programs. To approach this problem, the Center for Student Success (CSS) engaged in a study, funded by the Health Care Initiative, designed to improve the prediction of successful student completion in Associate Degree Nursing (ADN) programs. The study had three goals:

1. Review the relevant literature on selection with regard to nursing student program outcomes and use that review to inform the current investigation;
2. Document the past and current success rates of new ADN students entering ADN programs; and,
3. Develop a statistical selection model that improves current program completion rates.

To support this investigation and provide guidance in the selection and modeling of variables to include in the ADN investigation, a comprehensive review of prior ADN program outcome studies was conducted. The literature review found that the topic of selection into ADN programs has had a long history. Identification of selection factors has been problematic for almost as long as there have been ADN training programs.

Of utmost importance to the success of the study, the research team recognized the need to use the literature review as a guide to select and model variables that have been found to be empirically related to successful ADN program completion. Building on this body of prior research in the field, the research team set out to develop a model that could be both useful and applicable. Another goal of the research team was to develop a predictive model that would use selection data commonly available to ADN training programs, thus avoiding additional data collection from the students and faculty such as surveys. Consequently, the literature review informed the use of actuarial data and the development of a useful taxonomy to classify variables along three dimensions; institutional, situational, and dispositional. The classification of student and institutional level variables into the three categories was particularly useful in the development of a model that yielded the highest degree of predictive power for ADN program completion.

The literature review also helped the research team to develop a list of commonly collected data that would enable wide applicability across the broad array of California Community College Associate Degree Nursing Programs.

Another focus of the literature review was the acknowledgment and debate over access versus quality. The literature revealed concerns over the relationship between open-admissions policies for ADN programs and student outcomes in community college nursing programs from two decades ago. These issues still sound remarkably contemporary. Many of the current concerns about over-subscription to, and high attrition rates from, California Community College ADN programs can be found in the rationale for studies from several years ago. A general concern over rising rates of attrition by students enrolled in ADN programs prompted several studies focusing on ways to provide open-access with few requirements for admission, while at the same time attempting to reduce high rates of attrition. The debate becomes particularly acute when the problem of nursing shortages in California is contrasted with increasing rates of attrition from ADN programs. Therefore, a primary focus of this investigation was to enhance the likelihood of successful program completion by admitted ADN students, thereby attempting to reduce attrition and dropout from ADN programs while maintaining access with opportunity. The literature revealed costs associated with high attrition rates. These include the opportunity costs accruing to students who do not complete their training, as well as the attendant costs of attrition borne by the ADN programs, the community colleges, and the state, particularly when confronting a shortage of nurses statewide.

In developing the study, and for purposes of data gathering, a series of meetings with ADN nursing directors was conducted. These meetings served to provide the research team a solid foundation upon which to conduct the study and to solicit the directors' help in understanding their current selection processes.

Consistent with the longitudinal design of the study, nursing student data were collected from the Chancellor's Office of the California Community Colleges MIS system for a five year cohort; 1994-95 through 1998-99. This five-year cohort was chosen in an effort to assure that the most accurate data were included in the analysis. The team analyzed the selection methods of the colleges and their relationship to program completion. Moreover, student factors that were related to successful program completion were also analyzed. Selection methods were described by the nursing directors, and descriptive information about selection of ADN nursing students as well as their subsequent success rates were analyzed. Overall, 5,007 students were included in the study cohort, representing 20 different ADN programs across the state.

Analysis of trends in ADN program completion for the five-year cohort confirmed the perceptions of increasing attrition expressed by the ADN program directors. Success rates of ADN students have decreased from about 82% in 1994-95 to about 73% in 1998-99. Furthermore, differential success rates between various demographic groups by age, ethnicity, gender and primary language were identified.

In the development of a prediction model, almost 50 variables were tested to determine their relationship with the dependent variable of program completion. Four factors rose to the top of the class in the prediction model; Overall College GPA, English GPA and Core Biology GPA (Anatomy, Physiology and Microbiology); and Core Biology repetitions (the number of times a student repeats any of the core biology courses). Logistic regression was used to form a composite measure. The application of these variables significantly improved the prediction of ADN program completion. Success rates rose from the 1998-99 completion rate of 73% to 82%. When disaggregated by ethnicity, use of the composite formula to predict success resulted in improved completion rates for ethnic groupings. For example, the rate of increase for White students was approximately 3%, while for African American students, use of the composite variable for program admission improved completion rates by approximately 15%.

Although no composite formula is a perfect predictor of student success, the researchers were able to use standard variables in a composite formula to improve success rates without reducing the success rates for any ethnic group. Therefore, a guiding principle of predictive validity studies, that of "do no harm," was not violated and in fact, resulted in improved success rates for minority students compared with current program outcomes for these groupings.

In conclusion, this study sought a measure to be used in the selection of students that would improve the successful program completion of ADN students in California community colleges. While not a perfect solution, this composite predictor goes a long way toward improving ADN student success. Given the current nursing shortage in the state of California, any change in selection that might improve the throughput of students to qualified nurses needs serious consideration. The proposed composite measure would do that without any corresponding increase in the cost of education to community colleges. It is the hope of the research team that California Community Colleges system will carefully consider the advantages that can be gained by such a method.

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BACKGROUND TO THE STUDY

What is the Associate Degree Nursing (ADN) Project? A joint project involving scholars, educational researchers, and analysts from the Center for Student Success (CSS) housed at City College of San Francisco. A team of experts from CSS has been assembled to work closely with the ADN consortium of community colleges nursing directors and the Chancellor's Office of the California Community Colleges (COCCC) Economic Development Program's Health Care Initiative, to develop, conduct, analyze, and disseminate the findings of the proposed research project.

Why is the ADN Project Needed? Health care providers from throughout California have been voicing concern about the lack of qualified registered nurses (RN's) to meet the state's growing health care needs. This reflects a trend identified in other regions of the nation (Suarez, 1991). Although there are several reasons for this shortage that are beyond the control of the community colleges (competitive labor markets, wages and working conditions, costs of training), health care experts also cite a relatively high attrition rate of nursing students as an important factor. Attrition in nursing programs is believed by nursing faculty to be related to the lack of required core prerequisites for entry into ADN programs. In addition, inconsistency over the identification and application of required prerequisite courses across college programs has hampered attempts to create a core of prerequisite courses that would be consistently applied in college ADN programs. Development and implementation of a required core of ADN program prerequisite courses requires that performance in prerequisite courses have an empirically-derived statistical relationship to success in ADN programs. This project will assist California Community College ADN program providers with sound, empirically-derived evidence to identify a core of prerequisite courses and the statistical relation of performance in these courses to ADN program completion.

How will the ADN Project Work to Develop Prerequisite Standards for Community College Nursing Programs? Through the application of sound research principles, CSS analysts conducted an extensive literature review of prior work in this area to inform the present study. This review of prior prerequisite and predictive validity research, in addition to the rich and extensive experience of project staff in the conduct of such studies, has enabled the CSS team to identify a set of useful student background data, course experiences and outcomes. The team has analyzed the relation of student preparation and success in prerequisite courses to the outcome of successful completion of nursing programs in the ADN consortium. Based on the strength of the observed relationships between prerequisite courses and nursing program completion, the CSS team will make recommendations to the Project Monitor, ADN stakeholders, COCCC staff, and health care stakeholders as to the identification of prerequisite courses and other relevant student data for ADN program eligibility.

The ADN Project

Introduction

California faces a severe nursing shortage. As is the case in several other states, the number of registered nurses available to provide health care and services is far below what is required to avert a potential state health care crisis. According to a recent article in the New York Times, (Janofsky, 2002), hospitals in several states are trying to lure nurses with flexible hours, ever-larger signing bonuses and other financial incentives. This has resulted in some hospitals conducting bidding wars to attract qualified registered nurses. As the population grows, and with the aging of the baby boomers, many anticipate that supply problem will worsen. Although there are several reasons for the current shortage of registered nurses, high attrition rates from nursing programs is frequently cited as one of the most important causes for the under-supply of nurses. Therefore, a primary problem facing ADN programs is the identification of prerequisite skills and knowledge needed to select students with a relatively high probability of successful program completion. This is the primary goal of this investigation.

The problem of identifying and validating prerequisite knowledge and skills for ADN nursing programs is not new. The problem has been described, studied, researched, and reported extensively over the past quarter-century in a variety of articles, reports, studies, foundation papers, theses, dissertations, and technical reports. A review of the rationale and approaches of several past studies reveals that many of the same vexing problems described in the "Request for Proposals" of the study, also formed the basis for research and evaluation by a number of researchers, administrators, faculty and professional associations. (Eller, et. al. 1975; Brawer, 1978; Belcher, 1989).

Prerequisites in the California Community Colleges: The Policy Background

According to documents and regulations approved by the Community College Board of Governors (BOG) and published by the Chancellor's Office of the California Community Colleges (COCCC, 1997) and the State Academic Senate (Scroggins, et. al., 1997), prerequisites are an integral part of the community college curriculum. The rationale for the implementation of prerequisites is derived from the notion of providing the best fit between the entering abilities of the student and the curricular demands of the course. Prerequisites help to ensure that students have the necessary abilities and background to succeed in a course. In addition, prerequisites are intended to create a more homogeneous student grouping in terms of aptitude and ability. This use of prerequisites to screen entry to courses or programs of study is intended to populate a classroom with a group of individuals who can move together through a course's content or program of study. Prerequisites are intended to improve student retention and success rates by ensuring a common background of knowledge, abilities, experiences and aptitudes (Armstrong, 1997). This is believed to improve the match, or aptitude-treatment interaction, of students with advanced courses of study (Willingham, 1974).

In addition to content review criteria for implementing a prerequisite, State Matriculation Regulations require that an empirical, or statistical, relationship be demonstrated between a course and its respective prerequisite before implementing a mandatory prerequisite

requirement. The regulations state that the "prerequisite for a course shall be clearly related to course content and must be validated as being necessary for success in such course." [(Section 58106 (c) (2))] The Regulations further state that:

> In order to show that a prerequisite is necessary for success in a particular course, the validation procedure must ensure that a student who has not met the prerequisite is *highly unlikely to obtain a satisfactory grade in the course*." [Section 58106 (e)]. (emphasis added)

One primary purpose of this investigation is to collect criterion-related validity evidence of a prerequisite course or set of courses used as a gateway for additional courses. This design relies on quantitative and statistical methods to compile the necessary evidence to ensure nursing program viability and integrity; maintain fidelity with state and federal statutes regarding access; and promote student equity, fairness, and success in ADN programs.

Conceptual Approaches to Predicting College Program Performance

In a review of applicable theory for use in positing relationships among student level variables, program characteristics, and academic success, the present investigation was greatly informed by theory. Theory served this study by providing a useful framework or organizational tool to arrange disparate observations about students into coherent relationships. The present investigation drew upon a multi-disciplinary base of theories that focused on measurement, student biographical characteristics, and predictive validity. The application of pertinent theory was useful in identifying variables for analysis, and to posit relationships between the student variables and student program performance outcomes.

Predictive validity models were also useful in placing this study in context with prior research on Associate Degree Nursing students. As with other studies that examine the relation of prior and current performance to an educational or training outcome at some future time, this study focuses on the defensibility of academic requirements and other prerequisite measures used to predict performance in community college nursing programs.

This investigation also demonstrated how attempts to make optimal educational placement decisions through the use of course requirements, skill level and other prerequisites may be confounded by measurement error, differing characteristics of students, or the instability of the criterion variables of course grade, retention, and graduation. The open-access mission of the California Community Colleges practically ensures that the students served will differ tremendously in their experiences, levels of education, cultural backgrounds and socioeconomic status. Thus, predicting success is made more difficult by the diversity in the dispositional and situational characteristics of students. In addition, the defensibility of criteria used for program admission or course placement may be confounded by institutional practices used to select students, and programmatic differences in the evaluation practices and approaches to instruction.

A review of prior studies enabled this investigation to anticipate various sources of measurement error and to attempt to control for these at the outset. Predictive validity studies in community colleges or other educational settings are often hampered by the pre-sorting of students as either eligible or ineligible for a course or program (Sheldon, 1970; Cronbach, 1971, Chancellor's Office of the California Community Colleges, 1991). Pre-sorting or screening students truncates the range of student academic, dispositional and situational characteristics. Students with lower placement levels, for example, may be prevented from enrolling in a program. Thus, the performance of students deemed ineligible is difficult to measure or infer. A truncated distribution often results in lowered predictive validity or correlation coefficients between predictor and criterion variables.

In an attempt to lessen the threat to validity, this study used longitudinal data from several institutions with widely varying criteria for entry or admission to a nursing program. The present investigation also developed and used multiple indicators about individual aptitude for success in course and program completion. This was accomplished in part through the use of transcripts containing biographical and academic longitudinal data on study participants. In addition, the use of multivariate statistical techniques enabled the consideration of a wide range of independent variables to predict success in ADN programs. This approach has proven useful in studies designed to predict student success in community college and traditionally open-access educational settings.

Useful to this investigation was the literature on student development, retention, and success. Student retention theory provides a basis for organizing student biographical and academic characteristics into coherent groupings or categories. After a review of several student retention and college performance theories, most notably those of Tinto (1993 and 1982); Pascarella and Terenzini (1991); Bean, (1982), and Astin (1975); the scheme or rationale identified by Cross (1981) was found to be the most suitable for modeling the characteristics of the study participants and the data used in prior studies. Using Cross' recommendations and approach for studying student success in the community college, the review of literature attempts to group participant biographical data into situational and dispositional variables. The Cross scheme for grouping student variables was used to model the effect of institutional, situational, and dispositional characteristics on the program performance outcomes identified in the studies reviewed here.

Institutional Factors Affecting Success

According to Cross, institutional reasons for community college or adult student performance may include the practices and procedures that can contribute to or discourage adult students from program completion. Institutional reasons include inconvenient scheduling of necessary courses or location of classes, maintaining a full course load, and mandatory prerequisite courses or skills required before enrollment in a course or program of study.

In the review of literature to inform the present investigation, it was found that most studies failed to identify potentially salient characteristics of various programs such as

those identified by Cross. However, the present study does employ some proxies or measures of institutional factors such as methods used to select and group students for admittance into programs. Examples include institutional policies to allocate available space in an ADN program such as the use of a lottery to select candidates, first-come – first-served, scores on assessment tests, or completion of a set of prerequisite courses with a minimum grade point average. In the present investigation, previous research was used to identify such policies or institutional factors, and their posited effects on student outcomes, to help guide this analysis and to assist in the interpretation of findings.

Situational Factors Affecting Success

According to Cross, situational factors or reasons for adult student performance in school are those that arise from a student's life situation at a given time. Situational reasons for attrition or course performance are often unpredictable and frequently result in a lack of adequate time for devotion to educational pursuits. Situational demands may include family needs such as child care, the needs of a spouse, changes in work schedules or job responsibilities, transportation problems, moving, or medical problems. Lack of money and material resources is frequently a problem for many community college students and they must often work part or full-time to support themselves or help support their families. This situation frequently confronts many community college students and was cited often in the literature and prior research as possible barriers to success. However it was also noted in the literature that dispositional variables tend to have greater explanatory or predictive power than situational data. With respect to the present investigation, situational variables were not salient to the final model for explaining variance in program outcomes. Situational data are often by their very nature desultory, transitory, and resist systematic measurement when studies are conducted longitudinally. The design for the present investigation did not afford the systematic gathering and use of situational data in the final model. The primary source of the longitudinal data used in this investigation was from the statewide database developed by the COCCC. Although this database enabled the compilation and examination of nursing student program outcomes over a period of several years, the amount and reliability of extant situational data in the files was relatively low. For example, situational data such as family size, socio-economic status, childcare needs, and financial need are either not available or not regularly updated in the state database. The gathering of situational data would have to be done using surveys of the cohorts tracked in this study, and these data would have to be updated periodically. The use of retrospective data for this investigation made the creation and gathering of new data highly problematic. It was further observed by the investigators that in several prior studies reviewed for this project, situational data were not potent predictors or held comparatively little explanatory power when compared with dispositional variables. Thus it was determined that the costs of acquiring such situational data exceeded the expected relative benefits of such data. In addition, the gathering of situational data was felt by many practitioners to be exorbitant and technically difficult with little benefit in terms of enhancing the explanatory or predictive power of the selection model. Therefore the expected value and hence use of situational data was not emphasized in the present investigation.

Dispositional Characteristics Affecting Success

The third set of variables identified by Cross in modeling or grouping factors related to course performance and program completion is referred to as dispositional factors. Dispositional variables are those that derive from the behaviors, attitudes, self-perceptions, and abilities of the student. For example, many community college students may be uncertain of their ability to perform adequately in college based on past performance or other feedback from counselors, faculty, administrators, peers, and those closest to the student.

According to Cross, student dispositional characteristics include the prior preparation and academic abilities of the student. Indicators of the past performance of the student in school settings may be the most useful in predicting or explaining future performance and course completion. This is supported in the survey of relevant literature and is also consistent with prior research in personnel and industrial psychology that suggests that future performance is best understood in the context of similar performance in the past. For example, most studies employed some prior indicator of ability from previous school experiences such as the high school grade point average or course grades received in courses requiring knowledge of content relevant to required courses in nursing programs. The value of dispositional data with respect to explaining or modeling student course performance was noted throughout the literature and contributed to the identification, operation, and modeling of student dispositional data for use in the present investigation.

Using information provided by theories of predicting human performance developed in personnel psychology, the present investigation was able to demonstrate the potential value of student biographical and trait information in placement and prediction. The Cross taxonomy using student dispositional and institutional variables was used to make predictive validity theory operational in this investigation.

REVIEW OF LITERATURE

Providing Context for the Current Investigation

This section highlights prior research and evaluation studies in the area of community college ADN programs. This literature review is used to frame the issues surrounding predictive validity and the use of student biographical and educational data to make inferences about the potential future performance of an individual student. The review conducted for this study showed some variation in the primary focus of two-year college nursing programs and in the disciplines used as prerequisites. Although not uniform in the emphasis on prerequisites, most nursing programs reviewed tended to rely on the academic achievement of applicants as a basis for selecting students to admit. Generally, academic achievement was determined by performance in entry or pre-program courses in the sciences such as biology, chemistry and anatomy. The literature described problems and approaches in identifying factors predicting success in ADN programs and selected core nursing courses and provided valuable grist for the current study.

From the inception of the first community college associate degree nursing program in the early 1950's, the debates over program access and excellence in nursing program outcomes have continued unabated (Moore, 1981). The inherent tension produced by the promise of open-access on the one hand, combined with the need to enforce academic standards on the other, has promoted continued discussion and sometimes heated debate. For example, Bissett (1995) critically examined the ethical conflict in community college nursing programs between the value placed on equal educational opportunity and the need for quality and high academic standards. In this article, Bissett presented both sides of the debate for and against open admission to associate degree nursing programs. Although written more than 40 years since the debut of the first associate degree nursing program in the nation, similar arguments can be found, either implicitly or explicitly stated, in studies dating back to the earliest reviews of these programs. The general debate over access versus excellence in higher education becomes particularly strident when programs such as nursing are forced to reduce access due to limited resources, space, faculty, and classrooms.

These debates over access and high academic standards have formed the basis of a number of research articles, evaluation papers, and other investigations into how best to improve nursing student retention, completion, and performance on state licensure exams. These concerns were reflected throughout nearly all the studies reviewed for this investigation.

As noted above, although there has been a fair amount of research conducted on the topic of explaining or predicting success in community college ADN programs, much of the research has been of a descriptive rather than inferential nature. A review of past studies suggests a relative paucity of material focusing on predicting or explaining success in academic programs for the health professions generally, and the ADN programs specifically. Also, many of the studies found in the literature search were conducted in states other than California and may lack direct applicability to the unique population and characteristics of ADN programs in the state. Thus this project attempts to fill a gap in

the corpus of predictive validity studies in nursing programs by systematically identifying variables that show predictive power regarding the success of students admitted to ADN programs in California community colleges.

Access Versus Quality

Many of the current concerns about ADN programs, which served as the impetus behind this study, can be found in the rationale for other recent studies. For example, a concern over rising rates of attrition by students enrolled in associate degree nursing programs prompted researchers at the Connecticut State Department of Education to conduct exploratory and inferential research on retention in ADN programs in a large community college in Connecticut. Citing a national attrition rate from ADN programs of approximately one-third (Bello, et. al., 1977) and a local attrition rate of approximately 41%, Bello and others identified and analyzed factors associated with success in completing ADN programs. They cited what they perceived as a persistent and growing problem: increasing numbers of students entering the community college nursing program and either failing academically or withdrawing from the ADN program.

The Bello study focused on five areas or factors that could be used as predictors of eventual success in ADN programs. The data they used for the study included dispositional or what they termed "pre-program" data such as high school grades, rank in high school class, grades in high school algebra, biology and chemistry, and English, reading, and mathematics assessment scores. They also collected and analyzed situational data on the participants such as marital status, number of dependents, and hours spent working. Their study also determined if science grades were correlated with grades in nursing courses, as well as exploring the predictive validity of the National League for Nursing (NLN) tests for the Connecticut State Board Test Pool Examinations in Nursing. Consistent with the present study, they determined that the variables with the greatest explanatory power were the dispositional ("pre-program") and institutional ("program data"). Dispositional variables used in the final explanatory model included age, standardized assessment test scores, and grades in high school algebra. Institutional or program data included the use of grades in college science courses. The researchers concluded that nursing programs in the Connecticut community colleges could improve retention, graduation, and success on the state board exams by raising the minimum grade required in college science courses in chemistry and biology to at least a 'C' in order to remain eligible for the nursing program, and enforce minimum skill levels in reading and mathematics.

The problems of nursing program over-subscription and poor academic outcomes and representation of minority students formed the basis of a study conducted by Brown (1977). This study, conducted at the City College of San Francisco (CCSF), found that dispositional data tended to be of greater predictive value than other methods of selection. Using survey and interview data collected from nursing department chairs from 51 California community colleges, and quantitative analysis of nursing student outcomes at CCSF, this study compared the program outcomes of students admitted under different admission scenarios. These scenarios included the use of grades and test scores, minimum grades in prerequisite courses such as science and mathematics courses,

interviews only, selection by lottery, and some combination of the four methods. The study recommended that more qualified minority students could be admitted if nursing programs placed greater emphasis on pre-collegiate education and training while also providing extensive counseling and guidance services. In addition, Brown recommended that programs use a type of job sample test such as a demonstration of aptitude in clinical skills. Although not explicitly stated as such in the study, this recommendation comports well with the tenets of point-to-point theory where similarities or common variance between predictor and criterion tend to enhance predictive validity (Asher, 1974).

In contrast to the majority of studies reviewed, a study conducted by Grzegorczyk (1995), found little or no relationship between admission requirements, program characteristics, and student success. Interestingly, in this study, institutional variation as measured by regional accreditation status contributed the most explanatory power to the model predicting student success in nursing programs across five states. Of the studies reviewed, the findings from this particular study were the most anomalous.

Student dispositional data were found to be of greater value than either situational or program specific data in predicting the success rates of students enrolled in nursing programs in the North Carolina Community College System (Petty & Todd, 1985). The analysis, conducted in several community colleges in North Carolina, found that the age of the student (older), certain admissions tests in mathematics, reading, and the sciences, and "student personal characteristics" had predictive power in relation to the GPA of enrolled nursing students. The researchers developed 11 admission factors or models for selection of nursing students. These models were made up largely from dispositional data such as prior GPA, performance in similar courses, and achievement as demonstrated by performance on content specific tests using training-related concepts and vocabulary.

Some community college nursing programs focused on the completion rates of their students and the subsequent performance of students on state licensing exams. Illustrative of this line of research was the study conducted by Naron & Widlak (1991) at Olive Harvey College (OHC) in Chicago. This study used correlational analysis to determine the predictive validity of pre-program course grades, test scores, "support" or foundational course grades, nursing course grades, and the number of repeated nursing and other required courses, in relation to program completion and scores on the National Council Licensure Examination for Registered Nurses (NCLEX-RN). The study found significant correlation coefficients between grades in several nursing courses, the score on a locally developed admission test that reflected course content, and the number of repeated nursing courses, on the program success of OHC students. As with the present investigation, the OHC researchers found that prior course grades, particularly those in required OHC nursing courses in the sciences, were positively related to program success. They also found a significant negative correlation between the number of course repetitions in either the pre-nursing or nursing levels, and student success in the nursing program and on the NLEX-RN examination. That is, the more times a student attempted the same course, the greater their likelihood of failure on the state licensing exam. The study recommended that OHC nursing program administrators provide more counseling

and advising to prospective nursing students at OHC, and that grades in prior course work be weighted heavily in the decision to admit a student.

The relationship between prerequisite skills as measured by an admission test and program success of nursing students was the subject of a study conducted by Schmidt (2000). Using logistic regression, the investigator found that scores on the Diagnostic Readiness Test (DRT), developed for use in nursing program admission, and scores on the National League for Nursing Pre-Admission test could predict success or failure on the NCLEX-RN. The results for over 5,000 students indicated that the DRT was a significant predictor of NCLEX-RN performance.

Stronck (1979) also examined a number of community college admission criteria for nursing programs and found that the most accurate predictors of future academic performance included the grade point average in previous courses, particularly pre-requisite courses, and entrance achievement tests. He found that qualitative data about the dispositional characteristics of the student, such as interviews and recommendation letters, was subjective and empirically unrelated to program completion or the GPA earned in nursing programs. Similar findings were also reported by Stieren (1981) in a study conducted for the Southern Illinois Collegiate Common Market/Associate Degree Nursing Consortium. This study also found that reliance on interviews and other subjective data about the applicant was not a useful strategy to select students with a high probability of nursing program completion.

The use of multiple measures to develop a profile of the successful nursing student was the focus of a study conducted by Lamoureux & Craig (1977). In this study, the analysts developed a profile of nursing students likely to complete a community college nursing program, and a profile of those students likely to drop out of a nursing program prior to completion. The measures used in the study were comprised of a battery of tests and questionnaires based upon cognitive, personality, attitude, vocational preference, and socioeconomic characteristics. The researchers analyzed the relationship between the 121 student level variables and data from test scores with program completion. Correlational analysis was used to select a sub-set of variables or composite scale that best predicted student success. As with the present study, the researchers found that dispositional variables were not only of greater predictive power in terms of nursing student success than other data such as socioeconomic status, but that combining certain variables such as data from test scores, combined science GPA's, and other dispositional data had significant predictive power. This research supports the approach used in the present investigation.

Personality Traits as Predictors of Success

The relation of student cognitive, affective, and behavioral characteristics to nursing program success and completion was the focus of a two-part study conducted over an eight-year period by Thurston, et. al.(1967). Concerned over rising attrition rates in nursing programs, the researchers set out to design an assessment instrument that would provide nursing schools with useful information about the personalities and potential problems of prospective students. The instrument they developed in the first phase of the

study used training-specific and contextual information to assess student aptitude and prior knowledge. The Luther Hospital Sentence Completions (LHSC) was constructed and scored using a Nursing Education Scale (NES). The new instrument was tested in two nursing programs and was able to detect significant differences in test performance between successful and failing students. The instrument was less sensitive, however, to differences in degrees of success; for example, in detecting statistical significance in scores between high- and low-achievers. In addition to the LHSC and the NES, the research team also developed two additional instruments for use in selecting students: the Nurse Attitudes Inventory and the Faculty Empathy Inventory. Concurrent validity was established for the instruments with other commonly referenced instruments such as the Minnesota Multiphasic Personality Inventory (MMPI), the ROTTER Incomplete Sentence Blank, and the National League for Nursing Pre-Nursing and Guidance Test. This comprehensive study found that prediction of student success in nursing education programs was somewhat complicated, but that quantitative and qualitative systematic assessment of student dispositional and personality traits could provide a valid and reliable model for predicting student success or failure.

The assessment of individual cognitive and affective traits and the relation of these traits to student grades and graduation from nursing school were also the focus of a study by Zagar (1982). This study focused on the predictive validity of the Edwards Personal Preference Schedule and the MMPI in relation to student performance in a hospital-based nursing diploma program. As with the Thurston study cited earlier, Zagar and his associates found that attitudinal and personality factors were related to nursing program success as measured by grade point average.

How do intellectual characteristics relate to successful completion of nursing programs and eventual placement in a job? This question guided the study by Tracy & Bauer (1979) where they attempted to correlate scores on the Structure of Intellect (SOI) instrument with nursing program completion, attrition, and satisfaction with vocational placement. The SOI identifies three factors of individual intellect: Operations (how an individual thinks or approaches problems), Content (the type of information presented), and Products (the manner in which the information is organized). The study suggested that the SOI could be a useful instrument in determining the intellectual traits associated with success in the nursing vocation, however, its usefulness for selecting competent candidates for nursing programs was limited. The researchers concluded that the SOI might be more useful in directing nursing applicants to special programs to remediate academic deficiencies.

Dispositional Variables and Nursing Program Outcomes

Dispositional variables were found to have the strongest predictive power for forecasting graduation of nursing students in a study conducted by Spahr (1995). This study was conducted with a sample of 255 nursing students in three separate entering cohorts from 1990-1992 at a community college in Illinois. Using multiple regression analysis, Spahr calculated the relation of entering GPA and grades in support or foundational courses in algebra, biology, and chemistry to graduation. Subsequent analysis of student outcomes using binary logistic regression led Spahr to conclude that the best predictor of

graduation status was a student's entering GPA, followed by grades in biology and chemistry. Although the regression weights of the course grades were statistically significant, they were relatively modest. Spahr also recommended that course grade data in the math and sciences be supplemented with other variables such as reading and computational skill level, and vocational aptitude and interest inventories. The value of entering GPA as a predictor of nursing program success was also found in a study using non-parametric analysis conducted by Wood (1990).

Concerns over a rising number of applications, combined with declining graduation rates, formed the basis for a study on nursing students by the Office of Institutional Research at Saint Petersburg Junior College in Florida (Dean & Fischer, 1992). A local task force on nursing program admissions and quality wanted to identify the minimum qualifications necessary for an entering student to succeed in a selective admission program at the college. In this study, success was defined as a student who completed the nursing program in four semesters and passed the Florida Licensing Examination for Registered Nurses on the first attempt. Four successive cohorts of generic nursing students were tracked over a four-semester time period and their outcomes analyzed. The predictor variables examined were the student's GPA at admission; scores on the Multiple Assessment Programs and Services (MAPS) placement test; final grades in selected mathematics, English, and science courses; and GPA's in other selected courses. Using multiple regression analysis, the study found that approximately 61% of the students in the study completed the program in four semesters, while another 20% completed the program in the fifth semester. With respect to performance on the state licensure examination, approximately 63% of the students passed the NCLEX-RN on the first attempt. Statistically significant pre-admission predictors of nursing program success included a final grade of at least a 'B' in the prerequisite courses of Human Anatomy and Physiology, and a GPA greater than 2.6 in general education science courses. This study highlighted the importance of past academic achievement in related coursework to graduation from a selective nursing program. These findings were also supported in the present investigation.

Conclusion: Past performance is the best predictor of success

It has been noted that predictive validity is essentially an attempt to approximate the future in the present. This notion was generally confirmed in the extensive literature review conducted for this study. With respect to this investigation, the literature review found that certain verifiable dispositional and biographical information about the student generally shows a significant positive relationship with performance, success, and graduation from nursing programs. This is consistent with research studies over the last 50 years that suggest that the single best predictor of college or program grade point average is the grade point average from prior courses in high school and college. This is consistent with the tenets of point-to-point theory (Asher, 1974), where information with the greatest validity shares common features with a criterion. Similar findings have been noted by Holland & Astin, 1962; Holland & Nichols, 1964; and Astin, 1975. In general, prior research efforts into the development of valid and reliable predictors of success in nursing programs have found that GPA in relevant science and foundational courses, particularly those that use vocationally relevant content to teach basic communication

and computation skills, are the strongest predictors of success and graduation in nursing programs. These findings lend support to the findings of the present investigation.

STUDY DESIGN

Description of the Study

The investigation evaluates nursing student performance using longitudinal data from the point of admission through program completion. According to higher education scholars and other social science researchers, longitudinal data are most informative in determining the impact or effect of a particular program, course, or experience on students over time (Astin, 1975, 1991; Adelman, 1989). The recommendations of these researchers influenced the research design of this study.

Determining the Cohort

Using data obtained from the twenty ADN consortium colleges, five cohorts of all students who enrolled in the nursing programs during the academic years of 1994-95 through 1998-99 were studied longitudinally to determine progress and performance. Student data were collected using electronic transcript information and other institutional records gathered from statewide Management Information System (MIS) data sources. The MIS data system is the standardized mechanism of data collection for the California Community Colleges system. The five cohorts were combined for a total population of 5,007 students. Using several years of longitudinal data the present investigation was able to model the relationship between various methods of program selection, prior courses, the effect of repeating courses on progress and performance, and the effect of science aptitude, with performance in course prerequisites on nursing students' outcomes.

A retrospective analysis was used to track students to see which courses they had taken before the start of their nursing curricula. They were also tracked forward to see which of them completed the nursing program within a three-year period following the start of their ADN courses. The start and end periods of the cohort were important. The 1994 starting date was chosen to allow the analysis of two years of prior course data. Since the state's database was first populated with data in summer 1992, the fall 1994 cohort date allowed for two years of prior data availability. The 1998 cohort date was chosen to allow a three-year time span following the start of ADN programs to program completion. The last data available for the analysis came from the 2001 school year. Most nursing programs are two-year programs only. However, several programs catered to part-time nursing students who required three years for completion. In other programs, there were small groups of students who required more than two years for program completion. Since the objective of the study was to predict program completion, it was necessary to allow a three-year time frame within which program completion could occur.

The start of an ADN program was defined as the attempt of three or more units of first term R.N. nursing courses. Since this definition might include students who were really not R.N. program students, each program in the consortium checked the names and dates of students against their records to determine whether they were indeed R.N. students. In about 95% of the cases, they were found to be legitimate R.N. program students. Any additions to and deletions from the cohort were made to bring it into compliance with the nursing program lists.

The end of the program was likewise defined as the successful completion of three or more units of fourth semester classes. Only students enrolled in generic R.N. programs were tracked. LVN and "step-up" program students were not included in the analysis. This definition was also problematic. Students meeting this definition were checked against the MIS database records of students awarded an associate degree in nursing. Although the two lists agreed in the vast majority of cases, since some students might complete a program without receiving an A.S. degree, the identified program completers were somewhat greater in number than those receiving a degree.

Developing a Model

The data were used to construct a model that explains variance and predicts successful program completion for ADN students by examining the dispositional and institutional characteristics of the sample. Prior research conducted by other analysts has empirically demonstrated the value of such data in predicting performance in a wide range of college courses, including nursing (Armstrong, 1999; Arnold, 1995). The data contained within the explanatory model included dispositional data such as high school and college GPA; the number of English, mathematics, biology, chemistry and other science courses taken; performance in foundational and other lower division courses; and the GPA of students in courses generally considered as foundational or prerequisite to nursing program entry or completion.

Data from institutional student records and other data sources such as program admission offices were used to construct a model that explains the highest proportion of variance in student success and successful program completion by ADN students. Correlation methods were applied to determine the common factors or groups of variables, such as science achievement, taken as a composite variable that included the grades earned from several different mathematics or science courses. These factors were entered as a block or group of variables into the prediction model. In the construction of the model, the logic of the sequencing and entry of predictor variables was closely examined to parallel the educational experiences of students and existing data at participating colleges. Variables explaining a statistically significant proportion of variance in the outcome variables of successful program completion were examined and weights identified. The philosophy of parsimony in the development of the final model guided the investigation and provided a strong rationale for recommendations for the implementation of course, skill, and student dispositional characteristics that best predict nursing program completion.

Variables Examined

A number of dispositional (including background), institutional and program selection variables were examined, as listed below.

Dispositional Factors

Factors	Area	Background Factors
GPA	College-wide	Ethnic Group
Units	Biological Sciences	First Language
Courses	Mathematics	Gender
Terms	English	Age
Repetitions of courses	Chemistry	
Percentage of units passed	Core Biology	
Percentage of units withdrawn	Microbiology	
	Anatomy	
	Physiology	
	Transfer	
	Non-transfer	
	Basic Skills	

Institutional Factors

Prerequisite Requirements

Number of Prerequisites	Chemistry Requirement
Prerequisite GPA	Sociology Requirement
English Requirement	Psychology Requirement
Math Requirement	Speech Requirement
Nutrition Requirement	Reading Requirement
Child Development Requirement	

Institutional Factors: Program Selection Variables

Variables

Selection (points, lottery, etc.)	Recommendations
Method (fixed or ranked)	Number of Courses Taken
Work Experience	Local Residency
Course Repetitions	High School Diploma
Interviews	Number of Times Applied to Program
Community Service	

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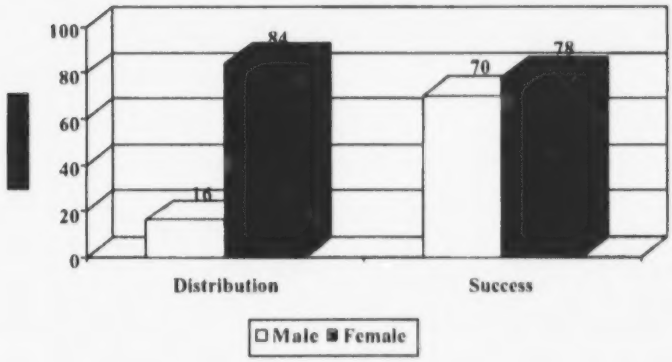
RESULTS

Demographics

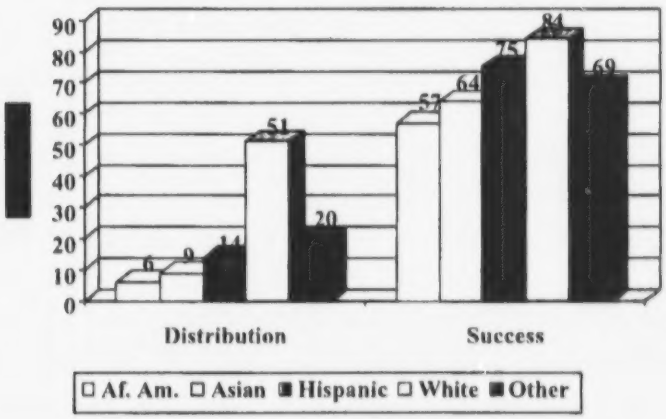
This section details the demographic and program completion profile of the cohort under study. First, the cohort demographics and success by demographic were examined. Next, the selection method for the years under study was reviewed to determine if there were changes over time. Following this, numerous variables were examined to determine how well they correlated with student success. Finally, a new model was derived using these variables and the predicted probabilities of successful student completion were plotted.

Gender and ADN Program Completion



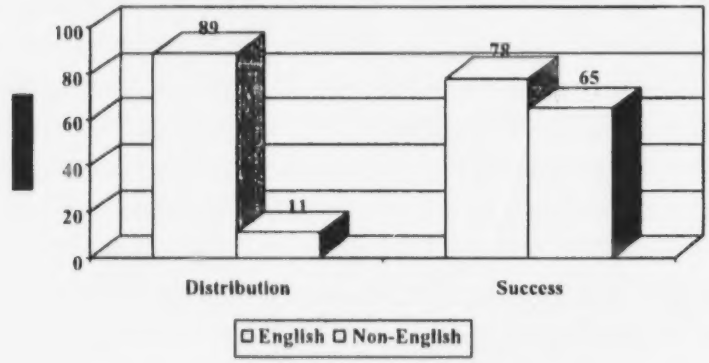
The cohort was 84% female, and 16% male. In regard to successful completion of the program, females were somewhat more successful than males (78% vs. 70%).

Ethnicity and ADN Program Completion



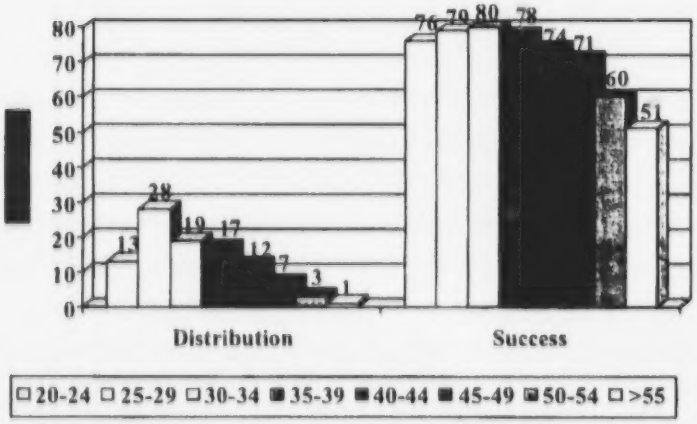
As shown above, the majority of students enrolled in ADN Nursing programs in the 20 colleges under study was White (51%). The second highest ethnic category, 'Other' comprised 20% of students, while Hispanic represented 14%. Asians and African Americans comprised 9% and 6% respectively. In regard to successful completion, Whites were the most successful with an 84% program completion rate, followed by Hispanics (75%), 'Other' races/ethnicity (69%), Asians (64%) and African Americans (57%).

Primary Language and ADN Program Completion



The primary language of most ADN students was English (89%), with 11% indicating a primary language other than English. Students with English as a primary language were somewhat more successful than those who speak another language as their primary language (78% vs. 65%).

Age and ADN Program Completion



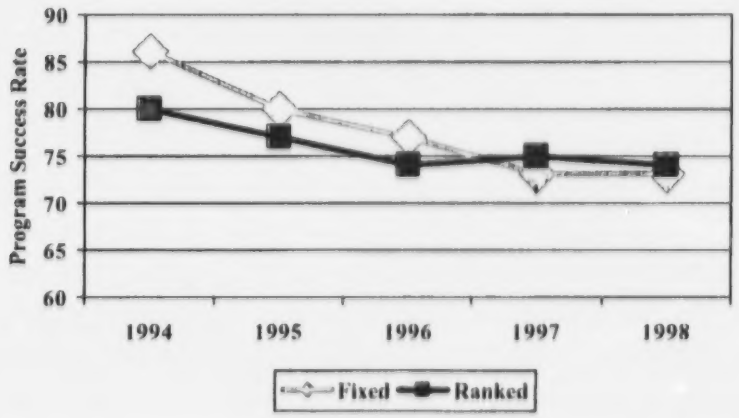
In regard to age, most students at the beginning of an ADN Nursing program were in the 25-29 age range, however ages were widely distributed, as displayed above. Over two-thirds of students (64%) were between the ages of 25 and 39. The most successful students were between the ages of 20 to 44, with those over 55 having the lowest success rates of just over 50%.

Institutional Factors in Selection and Program Completion

Key factors examined in assessing student success related to how colleges applied their selection criteria. These included selection types and methods, GPA prerequisites, and number and kind of requirements. The methods can be broadly categorized into two types: fixed and ranked. Fixed methods are those that set a minimum standard for entry and then use a lottery or first-come-first-served selection type to choose from the pool of applicants who meet the minimum standard. Ranked methods are those that, using criteria of some sort, rank students from high to low and select students in that order until all slots are filled.

Within the general categories of fixed and ranked methods, several selection procedures were used. Examples of fixed method selection procedures included lottery, first-come-first-served, and the 80/20 method. In this last method, which also included a lottery, 80% of the seats in the program were given to students whose grade point average was 3.0 or above while the remaining 20% went to students with 2.0 GPA's or higher. Each of the two groups of students were entered into a lottery and selected randomly. The primary ranked selection method was the point system, where students were given points on the basis of GPA, interviews, prior work experience, recommendations, etc. In some cases only GPA was used. Students could be ranked by either their high school or college GPA and, in the case of college GPA, some schools only used prerequisite GPA for ranking. At other schools, the number of prerequisites completed and the grades in those prerequisites were used to rank students. Lastly, some schools used multiple methods for selection. They accepted students with high school GPA's above 3.0 or students with a prior college degree, or students who had completed the nursing co-requisite courses.

Fixed vs. Ranked Selection Methods and ADN Program Completion



As displayed above, in the first cohort year (1994) that data were collected for this study, fixed methods had a much higher success rate than ranked methods (86% vs. 80%). Yet, in the next four years, success rates for both methods were reduced and, by 1998, were virtually indistinguishable at about 74%. In the first year, slightly more than 50% of nursing students were selected by a ranking method. By the last year, only 16% of students were so placed.

Prerequisite GPA and Program Completion

The table below displays the percent of students completing ADN programs in relation to the prerequisite GPA required for admission to that program. Only completion in programs with a fixed selection method was examined.

Program Completion by Prerequisite GPA

Prerequisite GPA	Percent of Group Completing Program
2	74%
2.3	72%
2.4	83%
2.5	74%
2.8	86%
Grand Total	76%

As shown, there is an apparent increase in program completion as prerequisite GPA increases. While this increase is statistically significant ($p < .0001$), it is not linear.

Programmatic Requirements and ADN Program Completion

Shown below are the program completion rates of students from programs with the requirements versus the completion rate of students from programs without them. Note that reading and chemistry requirements seemed to be more related to program completion than other requirements. In programs with reading as a selection requirement, 85% of students completed their ADN program, compared to 75% of students in programs without this requirement. Unfortunately, not enough programs collected information on students' reading abilities, making it difficult to use as a variable in a model of ADN completion. A number of disciplines (Psychology, Speech, Child Development, and Nutrition) showed significant differences in the opposite direction, meaning completion rates were higher when these disciplines were not program requirements.

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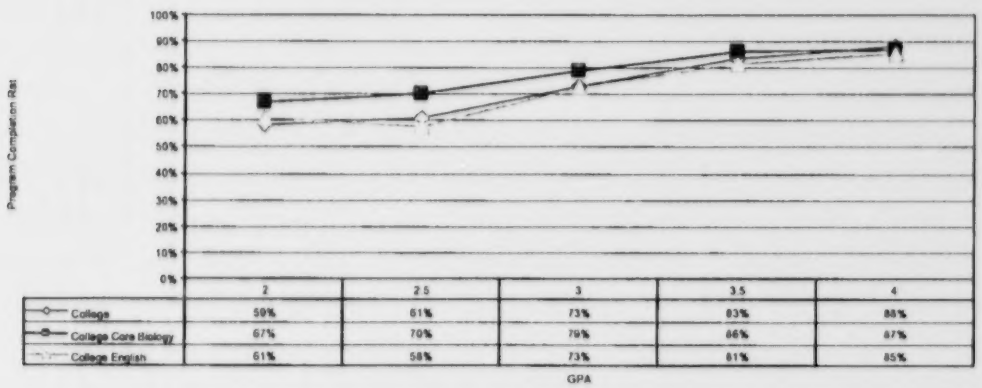
Program Completion Rate of Students from Programs With Varying Requirements

	Program Requirement?		
Requirement	Yes	No	Significant?
Reading	83%	75%	.0001
Chemistry	81%	74%	.0001
Mathematics	77%	76%	NS
English	76%	77%	NS
Sociology	75%	77%	NS
Psychology	73%	78%	.002
Speech	73%	77%	.006
Child Dev.	73%	77%	.05
Nutrition	72%	77%	.007

Dispositional Factors Correlated with ADN Program Completion

In an effort to build a usable and complete, yet simple, model that predicted program completion, a number of variables were examined for their relationship to program completion. Dispositional factors such as overall and specific course GPA, program requirements, courses, repetitions, demographic factors, etc., were examined. Consequently, a number of regression analyses were run between successful completion of the ADN program and each of the variables of interest. Consequently, the dependent variable of program completion was regressed against each of the variables of interest in an iterative process. The findings of these several regression analyses found that the variables with the greatest explanatory or predictive power were overall college GPA, English course GPA, core biology GPA (anatomy, physiology and microbiology), and core biology repetitions. These are presented below.

College, Core Biology and English GPA and Program Completion



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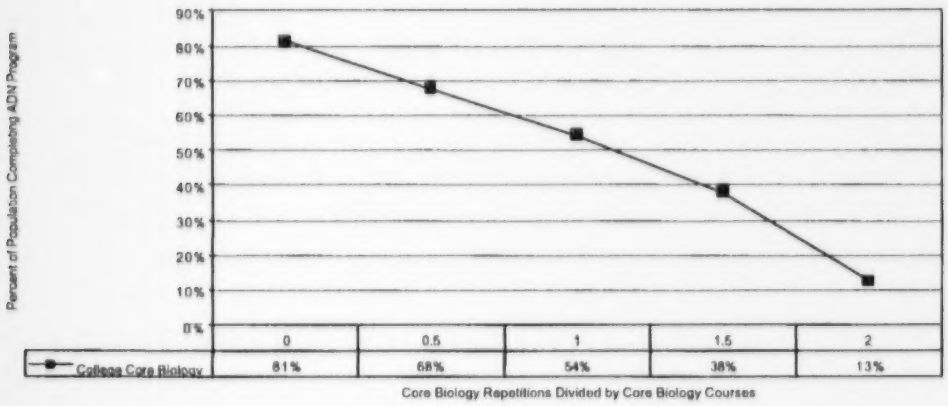
The chart above displays the relationship between overall college, core biology (anatomy, physiology, and microbiology), and English GPA earned before entering an ADN program, and later ADN program completion. As expected, program completion rates increased in relation to the increase in GPA. Core Biology showed the highest success rate followed by Overall College GPA, and then English GPA. For example, students who earned a 3.0 Core Biology GPA had a 79% successful completion rate, whereas students with an Overall College GPA of 3.0 had a 73% success rate.

Core Biology Repetitions and ADN Program Completion



Repetitions, defined by the number of repetitions divided by the number of courses, had an inverse relationship to program completion. As students repeated more courses, due to earning a 'W', 'I', 'D' or 'F' grade, their program completion rate declined. As displayed, students without evidence of any repetitions in core biology had the highest success rates, about 81%. Only 13% of those students who repeated each core biology course twice completed their ADN program. Furthermore, 77% of all students in the cohort had no core biology repetitions.

Development of a Composite Model

These GPA and repetitions factors were used to form a composite using the logistic regression procedure in SAS. The output below was generated.

Logistic Regression Output

Maximum Likelihood Analysis of Variance

Source	DF	Chi-Square	Pr > ChiSq
Intercept	1	12.66	0.0004
College GPA	1	2.47	0.1160
Core Biology GPA	1	4.26	0.0391
Core Biology Repetitions	1	33.05	<.0001
English GPA	1	8.76	0.0031
Likelihood Ratio	2E3	1777.17	0.2961

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Analysis of Maximum Likelihood Estimates

Parameter	Estimate	Standard Error	Chi- Square	Pr > ChiSq
Intercept	-1.3907	0.3908	12.66	0.0004
College GPA	0.3465	0.2205	2.47	0.1160
Core Biology GPA	0.2670	0.1294	4.26	0.0391
Core Biology Repetitions	-1.0279	0.1788	33.05	<.0001
English GPA	0.3139	0.1060	8.76	0.0031

There are several considerations associated with the logistic regression. First, no interactions nor quadratic and cubic trends were significant. A linear combination of the factors listed above was sufficient to explain the most variance. Secondly, the likelihood ratio was not significant, suggesting that the model fits the data (Agresti, 1996, pg 114-115). It must also be noted that students with over 21 terms of attendance were removed from the final equation as they were considered outliers.

It is also noted that prior college terms of attendance were also related to program completion. The more terms students had, the less likely they were to complete their ADN program. When all students were included in the model, the likelihood ratio was non-fitting (though the individual factors were significant). As a consequence, the model was fit for only those students who had fewer than 21 terms. This accounted for 91% of the population. According to Agresti (1996), it is not unusual to remove outliers to improve model fit in regression analysis.

From these parameter estimates a composite model was generated that predicted ADN program completion. That formula is given below.

$$\frac{\exp(-1.3907+.3465(\text{College GPA})+.3139(\text{English GPA})+.267(\text{Biology GPA})-1.0279(\text{Biology Reps}))}{(1+\exp(-1.3907+.3465(\text{College GPA})+.3139(\text{English GPA})+.267(\text{Biology GPA})-1.0279(\text{Biology Reps})))}$$

When each student's values for each variable are entered into this formula and the calculations performed, the result is a predicted probability of program completion. Consider this a composite score as well as a probability. The average predicted probability of program completion for actual program completers and non-completers is given below.

The Predicted Probability of Program Completion for Program Completers Versus Non-Completers

Program Completion	Mean	Standard Deviation	N
No	72%	14%	608
Yes	80%	10%	2045
Total	79%	12%	2653

Those students who completed their ADN program had a somewhat higher predicted probability of completion using this prediction model than those who did not. Overall,

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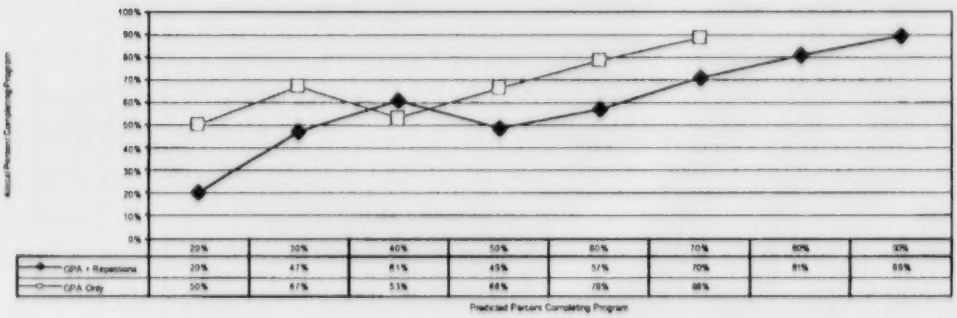
the model explained 8% of the variance, a small but significant improvement over current practice. The composite model, therefore, consists of the following variables.

- College GPA
- English GPA
- Biology GPA
- Biology Course Repetitions

Validity Evidence

The predicted probability of success was plotted against the actual success rates of students. While some nursing directors questioned the use of course repetitions in the composite, there was strong evidence that the use of repetitions greatly improved the prediction of success. Consequently, two composite measures were formed. One composite measure used GPA and repetitions and another used only the GPA. Displayed below is a depiction of predicted versus actual program completion for both composites.

Predicted Probability of Program Completion Plotted Against Actual Program Completion



The GPA-only plot was included in order to determine whether GPA alone was sufficient to predict success. As can be seen from the chart (and was apparent in the logistic output), GPA-only was inferior to GPA-plus repetitions in predicting program completion. The difference between predicted and actual program completions rates was greater for the GPA-only composite than the composite using GPA-plus repetitions. As a consequence, the chosen composite more accurately predicted program completion, especially at the lowest levels of program completion, where students were likely to fail. Therefore, the dual variables of GPA and repetitions were superior to GPA alone.

Some Prediction Examples

The question of many nursing directors, faculty and staff is "How does a typical student entering a program fare in terms of their predicted probability of program completion?" In the table below, nine hypothetical students were used as examples of the kinds of predicted probability of completion each one would have. For example, the first student has a GPA of 2.0 in all areas and no core biology repetitions, and their predicted

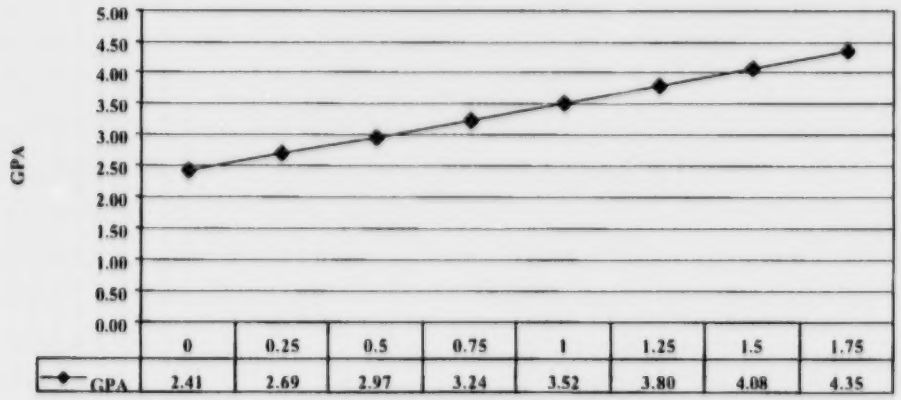
probability of completion is 61%. For a similar student (student 8) with a 3.0 GPA, the predicted probability of success is 80%. When students have core biology repetitions, the situation changes. Note student 2 with a GPA of 2.0 in each category and one core biology repetition for every class; the predicted probability of success in this case is 36%. For a student with a GPA of 3.0 and one repetition for each core biology course taken (i.e., .5), the predicted probability of success is 71% (student 7).

Prediction Examples Modeling Likely Student Factors

Student	College GPA	Core Biology GPA	English GPA	Core Biology Repetitions	Computed Probability of ADN Program Completion
1	2	2	2	0	61%
2	2	2	2	1	36%
3	2.5	3	2	1	47%
4	2.5	2.5	2.5	0	72%
5	2	3	2	0	68%
6	2	3	2	0.5	55%
7	3	3	3	0.5	71%
8	3	3	3	0	80%
9	4	4	4	0	91%

An additional question of interest relates to how overall college, English and core biology GPA and repetitions would play off each other in the selection of students. Assuming desire for at least a 70% predicted probability of program completion, and assuming that all GPA components are equal, the graph below presents that tradeoff.

Average GPA Required to Offset Repetitions of Core Biology Courses in Order to Achieve a 70% Probability of Program Completion



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As displayed, a student with no evidence of core biology repetitions and a 2.41 GPA would achieve a 70% likelihood of ADN program completion. Any student with more than 3 repetitions for every 2 courses (i.e. 1.5) would not qualify for entrance into a nursing program because they could not have a GPA higher than 4.0.

Using Program Completion Rates as Cut Scores

Another way to review the proposed model is to view completion rates through a cut score analysis. The website for the Academic Senate of the State of California Community Colleges offers publications on how to evaluate prerequisites. One article, "Good Practice for the Implementation of Prerequisites"[1] discusses a matrix or four-cell process. It says, "Standard research methods to evaluate the relationship between having the prerequisite and success in the course include a matrix or four-cell analysis showing *net increase in accuracy*, a comparison of the percentage of the students who succeed in the course before and after imposing the prerequisite. (Applying the prerequisite should show a significant gain in the percentage of students succeeding.)" In other words, consider the four cells below that specify the intersection of selection and program completion.

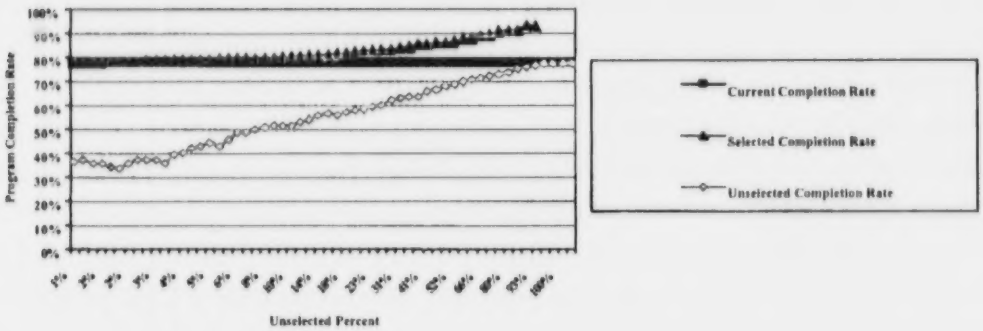
		Program	
Selection Method		Not Completed	Completed
	Selected	B	A
	Unselected	C	D

The net increase in accuracy would be the percentage gain in completion of those students selected over the current program completion rate. The current program completion rate would be (A+D)/(A+B+C+D). The new completion rate for selected students would be A/(A+B). The difference between these two would be the net gain in accuracy.

Another point of great interest in the state of California is the success rate of unselected students. This rate is D/(C+D). We would hope that with any valid selection method unselected students would have little if any chance of success, and consequently, that by not selecting them we are only saving them from going through a process that would be demoralizing and discouraging for them. A valid selection method should differentiate students so that selected students have a greater chance of success and unselected students have considerably less chance of success. The graph below presents the program completion rates of selected and unselected students compared to the current program completion rate. The net gain in accuracy would be the difference between the line representing selected students and the line representing the current completion rate.

[1] http://www.academicsenate.cc.ca.us/Academic%20Senate%20Web/Publications/Papers/good_practice_prerequis.html

Selection Using the Composite Model



In the chart above, the horizontal axis is the percentage of the population unselected at a given cut score. The vertical axis is the actual percentage of the population completing their ADN program. The current completion rate is displayed at 77% (which does not vary as students are unselected). Choosing a cut score that unselects 18% of the current ADN population would result in a completion rate of 57% for the 18% of unselected students. Of the 82% (100% - 18%) of students who would be selected, 81% would complete their ADN program. The net gain in accuracy over the current completion rate is 4% (81% - 77%).

Several aspects of this graph are worth noting. One is that the higher the cut score, the more successful the students who are selected become. By the same token, the higher the cut score, the more successful the unselected students become. When everyone is selected (no one is unselected) the program completion rate is the current rate. When nearly everyone is unselected, the program completion rate is the current completion rate. The net increase in accuracy or the net gain in program completion is a function of where the cut score for selection is set.

Good selection procedures show maximum differences in program completion between selected and unselected students. Consequently, at whatever cut score is chosen, a substantial difference between the completion rates of selected and unselected students should exist.

The table below presents the relationship between scores on the composite (specified as a predicted probability of program completion) and the percent of the population unselected at that score. It also presents the overall program completion rate of the group of students selected. For example, a composite score of 71% would unselect 20% of the current ADN students in this study. The program completion rate of the selected students would be 82%. Why would a predicted probability of completion be 71% while the overall program completion rate is 82%? This is because the 71% predicted probability of program completion would be the minimum expected rate of selected students. Since a

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number of students would have a higher predicted program completion rate, the overall rate would naturally be higher.

The Composite Score, Percent of Population Unselected, and Completion Rate of Selected Students

Composite Predicted Probability of Program Completion	Unselected Percent	Minimum Completion Rate
40%	1%	78%
56%	5%	79%
64%	10%	80%
68%	15%	81%
71%	20%	82%
74%	25%	83%
76%	31%	84%
79%	41%	85%
82%	52%	86%
84%	62%	88%
87%	75%	91%
89%	85%	91%
90%	90%	93%

Note in the table above that for all scores and percentages of unselected students, the overall selected completion rate exceeds the cut score (composite) minimum.

In a seminal paper, Meehl and Rosen (1955) discussed three criteria for selection. First was setting a score that maximized overall correct identification of successful and unsuccessful groups, second was setting a score that maximized correct prediction (the success) of the selected group, and last was setting a score that maximized correct prediction (the lack of success) of the unselected group (pp. "204-205"). They went on to say that overall correct identification was not always the bottom line. When there is an externally imposed selection rate it is best to use criteria that maximize the correct identification of the selected group. In ADN programs, there is an externally imposed selection rate. That selection rate is the number of seats in the program divided by the number of applicants. Given that not all students can be served, the issue becomes one of serving the students most likely to succeed. Those students, in this case, are those with higher predicted probabilities of success.

Disproportionate Impact

There are other considerations besides the success of students. Access to programs and the right to fail are also areas that need to be addressed when considering selection models for highly impacted programs. Access to programs for all groups is an important consideration when trying to promote diversity in the nursing profession. If high standards on a prediction instrument deny access disproportionately to minority groups,

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then such a selection method might be considered unfair. While the issue of access is important, the real question is access for what purpose. Access needs to lead to goal attainment. Without goal attainment, access becomes a meaningless exercise.

The following example demonstrates how the new model would affect various groups. A cut score of 70% predicted probability of success was applied to the cohort of students tracked in this study to determine its effects on various ethnic groups' program access and program completion rates.

The Impact of a Cut Score of 70% on Various Ethnic ADN Populations

Ethnicity	Original N	New N	Percent of the Original Cohort	Original Completers	New Completers	Current Completion Percent	New Completion Rate
African American	132	91	69	78	67	59%	74%
Asian	278	219	79	168	144	60%	66%
Latino/a	400	307	77	307	250	77%	81%
Other	525	397	76	366	293	70%	74%
White	1318	1171	89	1126	1025	85%	88%
Total	2653	2185	82	2045	1779	77%	81%

As displayed above, if a minimum predicted probability of successful completion of 70% is used, 18% of the current ADN population would be unselected. This translates to 2185/2653 or 82% of the current population that would be selected. This selection percent would not be constant across groups. For example, 91 of the current 132 African American students (69%) would be selected into the ADN program; of the 400 Latino/a students, 307 (77%) would be selected; and of the 1,318 White students, 1,171 (89%) would be selected. The differences by ethnicity vary by 20% from the African American to White percentages. However, this is not a valid comparison. Students entering ADN programs over the last five years were not aware of the criteria used in this study, therefore the differential selection rates merely show what the researchers were able to determine from student transcripts. Because this is a retrospective investigation, it is difficult to project forward and say if there will be a different impact on future Associate Degree Nursing students. For example, if ADN programs publish the entrance criteria suggested in this study, there is every reason to believe that all students will seek to excel in their educational endeavors in order to be accepted into ADN programs.

Nevertheless, it is important to look at how the suggested criteria affect those remaining in the cohort. As the table above displays, the current completion rate of African American students is 59%. For White students it is 85% – a 26% differential. If the new criteria of selection were implemented (and assuming the applicant population was similar to the population in the study cohort), 74% of the selected African American population would succeed versus 88% of the White population. The success rate differential would shrink to 14%. If one looks at the number of African American student completers who would be dropped out by the new selection system, it would be 78. Of these, 67 would remain, a difference of 11 students. One-hundred successful

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White students would not be selected. Successful students in other groups would also not be selected. However, according to Meehl and Rosen's argument, given that not all applicants can be served, it makes sense to serve those most likely to succeed.

Moreover, if a new higher standard were imposed, it is hard to know how many students in each ethnic group in the applicant population would meet that higher standard. Currently, most students are randomly selected from a pool of applicants, therefore, it is unknown what the distribution of ability by ethnicity in the applicant pool would be.

Prediction of Program Completion Rates by Background Variables

In an effort to determine the efficacy of the model for each subgroup, it is also important to determine how well a general prediction of program completion works for each group. Appendix 1 displays graphs that present the actual versus predicted probability of program completion for the overall cohort as well as for groups by ethnicity, gender, language background and age.

In nearly all cases, some discrepancies exist between predicted and actual program completion rates. However, in spite of this, there is an invariant up-trend in program completion for all groups. As predicted program completion rates increase, so do actual completion rates. So, while there is some over and under-prediction of program completion by the composite, in general, the composite prediction mirrors actual prediction. The composite is valid, but falls short of a "perfect" predictor of program completion.

The Composite Compared to Core Biology GPA Only

Appendix 2 displays results for the composite model versus the use of the core biology GPA only. This section displays the differences in using the derived composite model and the rational for including other variables such as overall college GPA, English GPA and the number of repetitions. In summary, selected students at all points are more successful and unselected students are less successful with the composite than with core biology GPA alone. Therefore, although the composite model is somewhat more complex than using core biology only, the result is improved prediction.

DISCUSSION

This study sought to accomplish three main goals:

1. Review the relevant literature on selection with regard to nursing student program outcomes and use that review to inform the current investigation;
2. Document the past and current success rates of new ADN students entering ADN programs; and,
3. Develop a statistical selection model that improves current program completion rates.

The review of the literature was thorough and reasonably complete, helping to provide a theoretical basis and to inform the statistical investigation. The review found that the topic of selection into ADN programs has had a long history. Selection factors have been identified as an important issue for almost as long as there have been ADN training programs. The literature review informed the use of actuarial data and the development of a useful taxonomy to classify variables along three dimensions; institutional, situational, and dispositional. Although situational data were not used in this study, due to database, cost, and time constraints as well as the practical application of the model in community college settings, the classification of student and institutional level variables into the categories was particularly useful in the development of a model that yielded the highest degree of predictive power for ADN program completion. The literature review also helped the research team to develop a list of commonly collected data that would enable wide applicability across the broad array of California Community College Associate Degree Nursing Programs.

Nevertheless, the relevant literature did not completely address the concerns of access and completion. While California and the rest of the nation is faced with a severe nursing shortage, access and completion become even more acute. This problem is further confounded by the lack of available resources to significantly increase the number of nursing training programs, especially in public higher education, where ADN training is significantly less costly to the student than the private sector.

Outcome data of the five-year cohort presents a thorough look at ADN program success from twenty California community colleges, using 5,007 students, over a five-year period. Differential success rates demonstrated that not all groups enter ADN programs equal to their proportions in the state population. Furthermore, not all groups complete at the same rate, suggesting that the system has some significant challenges if equity is to be achieved. These challenges include an emphasis on the preparation and success of more students in the sciences, particularly in the core biology sequences.

Clearly, the proposed composite formula models an improvement in current success rates of ADN program students. The following are the potential benefits:

- Improved completion rates
- Improved completion rates for all groups

- Standardizes selection criteria
- Provides a predicted completion rate
- Can be empirically tested and improved

Given the above benefits, the researchers feel that the composite model is clearly an improvement over past and present practices. Improved completion rates can increase the throughput for all groups and help to meet the growing demands for qualified nurses. By standardizing selection criteria, potential students know what they need to achieve in order to enter a nursing program. Finally, nursing programs will be able to test the efficacy of the composite model over time. Despite these benefits, there are some potential confounds to this study.

Potential Confounds to the Study

As with any empirical study, there are potential confounds stemming from both the literature review as well as the combined experience of the analysts involved in the investigation. These issues include confounds to the data on study participants, the distribution of abilities, the inability to conduct an adequate cross validation study, reliability of the prerequisite and the concern about equity.

Data on Study Participants: It was found by other community college researchers (Boughan, 1993), that nearly half the students avoided placement testing or failed to complete required developmental coursework prior to entering nursing programs. It was also found that a high proportion of students withdrew from programs from the point of entry-level assessment to program completion. It is sometimes difficult to establish who has had a prerequisite based on prior work or experience. This is one limitation of the state MIS system. Data were used from the 1994-95 cohort and later, but before 1993, the MIS system had some significant deficiencies, therefore the identification of prerequisites, (courses taken by the early cohort student before they began an ADN program – pre 1993) from the early cohorts is less than ideal. In addition, students may have obtained their prerequisites at other institutions, such as public and private universities. The statewide MIS system does not always capture these data.

Distribution of Abilities: A common problem facing post-hoc or retrospective prerequisite validation studies is the restriction of range of entering student abilities, backgrounds and aptitudes. To analyze the effect of student course or program eligibility status on outcomes, there must be a sufficient number of false positives, or students who are expected to fail but in fact are successful, and false negatives (students predicted to pass but in fact fail). If enforcement of prerequisites has been mandatory, then there are often too few students not meeting the prerequisite to ensure the validity of the findings.

Nursing programs pride themselves on their success rates, thereby reducing the number of those students who are not successful. From a researcher standpoint, this diminishes the number of false positives and makes it difficult to model false positives.

Cross Validation: Although this longitudinal study had a large sample size and the statistical assumptions of the procedures employed were met, only a little less than one-

third of the community college ADN programs participated. Without the ability to cross-validate the composite, e.g., use ADN students in the other colleges as test cases of the new composite model, there is somewhat less confidence in the outcomes.

Academic Standards Across Disciplines: Prerequisite course outcomes may not be reliable. A common issue in placement and assessment literature, the content mastery expectation by different instructors in an outcome course may also vary such that a reliable relationship cannot be demonstrated with the prerequisite. Nevertheless, this is an age-old issue that asserts itself when more than one faculty member is in the mix.

Equity Issues: At this point, it is difficult if not unworkable, to be fair to individuals in terms of equity, to groups in terms of parity or the avoidance of adverse impact, to institutions in terms of efficiency, and to society in terms of benefits and risks – all at the same time. In principle, a workable balancing of the needs of each of the parties is likely to require successive approximations over time (Meehl & Rosen, 1995). Despite this caveat, it is important that any adopted selection criteria make strides toward equality among the entering cohort while maintaining high, consistent standards. This may seem like a difficult goal to achieve, but the system should strive for it nevertheless.

Implementation Issues

If this composite is adopted by community colleges, it is important that it is phased in with enough time for students who intend on competing for impacted slots in ADN programs to obtain the appropriate prerequisites. It is unwise to simply "throw the switch" and implement the composite model without some appropriate and necessary planning in regard to program and student impact. Furthermore, ADN programs considering implementation of the composite model must prepare for implementation by adjusting their admissions policies and practices to accept the variables in the composite. While the composite formula can easily be adapted to electronically accept student data and generate a predicted probability of completion, it still takes time to develop the infrastructure to support the application process.

Final Comments and Next Steps

While the study was conducted with the highest degree of rigor possible for an empirical study, there will no doubt be detractors. It is important, then, to have this work not end as only a study aimed at improving selection criteria. A second study needs to be performed to determine what factors, if any, help to ensure the successful completion of ADN students once they are enrolled in a program. This second study would help to determine the "best practices" that ADN programs and students engage in that promote successful completion. Together with the information gleaned from the first study, program completion will most certainly improve and greater equity among student groupings can be achieved.

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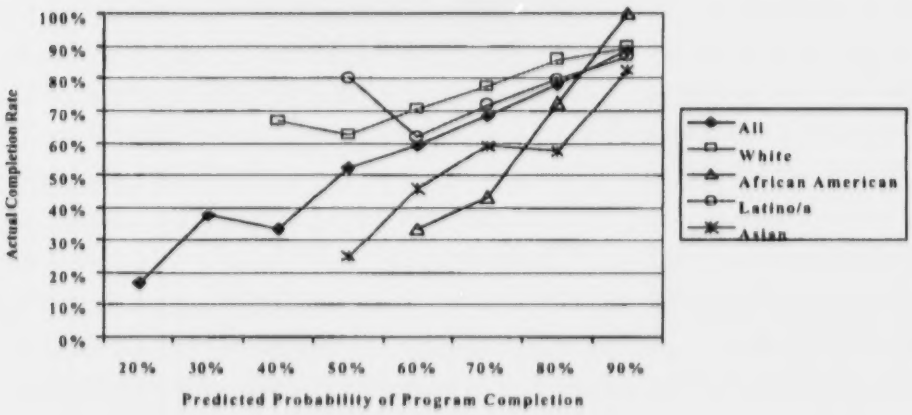
APPENDIX 1

BACKGROUND VARIABLES BY SUCCESS: OVER AND UNDER-PREDICTION OF SUCCESS

The following is a detailed examination of the predicted completion rates compared with actual completion rates for ethnicity, sex and age. In each chart below, the longer dark line represents all students. This line is consistent for each chart and it is the same line presented earlier displaying the composite validity. These new charts display the overall prediction as well as a prediction for each group. Lines below the line for 'All' imply that the overall line over-predicts this group's performance. For example, the predicted program completion rate for Asians is below the overall predicted line and their predicted performance is below their actual performance.

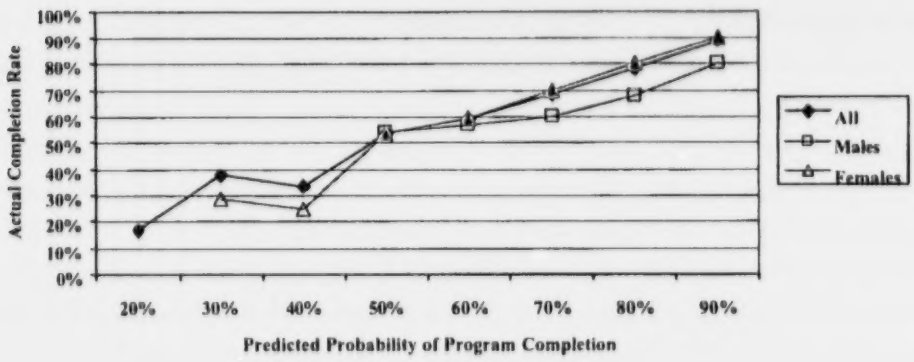
In nearly all cases, some discrepancies exist between predicted and actual program completion rates. However, in spite of this, there is an invariant up-trend in program completion for all groups. As predicted program completion rates increase, so do actual completion rates. So, while there is some over and under-prediction of program completion by the composite, in general, the composite prediction mirrors actual prediction. The composite is valid, but falls short of a "perfect" predictor of program completion.

Predicted Versus Actual Program Completion Rates by Ethnicity



As displayed above, some groups achieve above the predicted probability and some groups fall below their predicted completion rate. White students are consistently above the probability line, while Asian students are consistently below the line. African American students perform less well than expected at lower cut-off scores, however, at higher cut scores, African American students perform better than predicted. Latino students perform slightly better than expected.

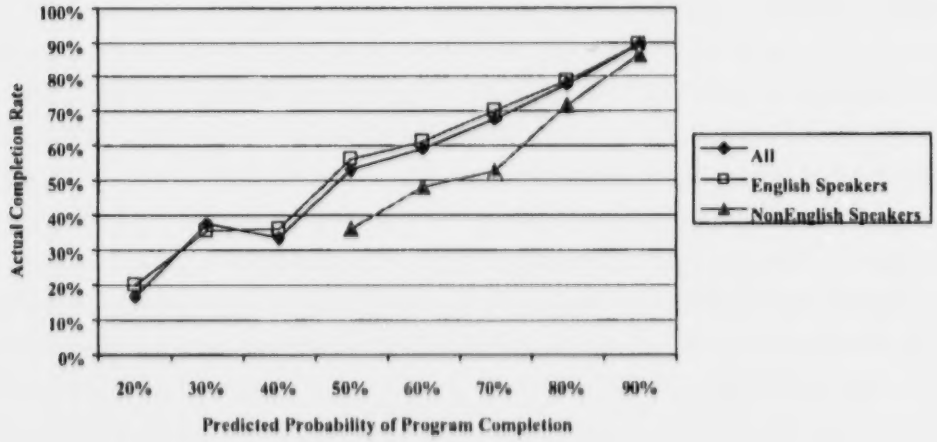
Predicted Versus Actual Program Completion Rates by Sex



As shown above, females complete the ADN programs at a slightly higher rate than predicted, males have a slightly lower rate.

Language background was also looked at to determine if any differential predictions occur.

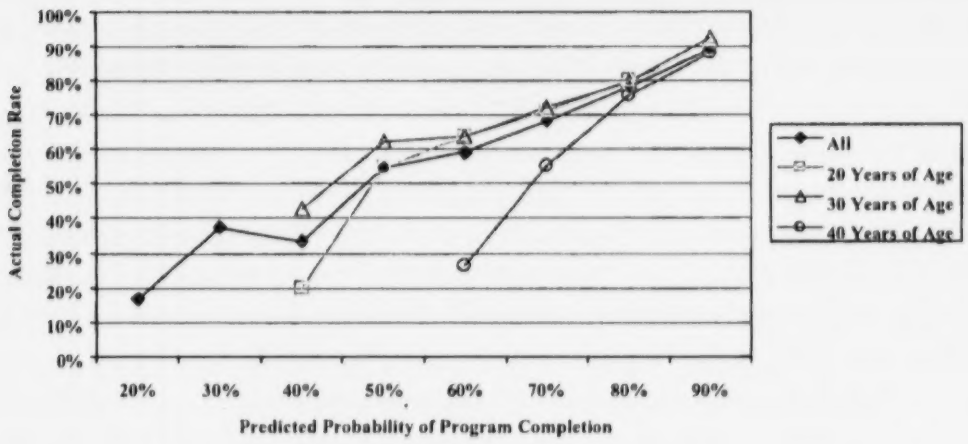
Predicted Versus Actual Program Completion Rates by Language Background



As shown above, while actual completion rates for English speakers are very close to their predicted rates, non-native speakers have significantly lower than predicted actual rates of completion.

Age of ADN program completers was also addressed as displayed below.

Predicted Versus Actual Program Completion Rates by Age



While the predicted completion rates for most age groups closely mirrors actual completion rates, the predicted rate for the 40 years and older age group is much lower for lower probability of prediction rates (60% - 70%). As the prediction rate increased, the 40 years and older rate mirrors the actual completion rate.

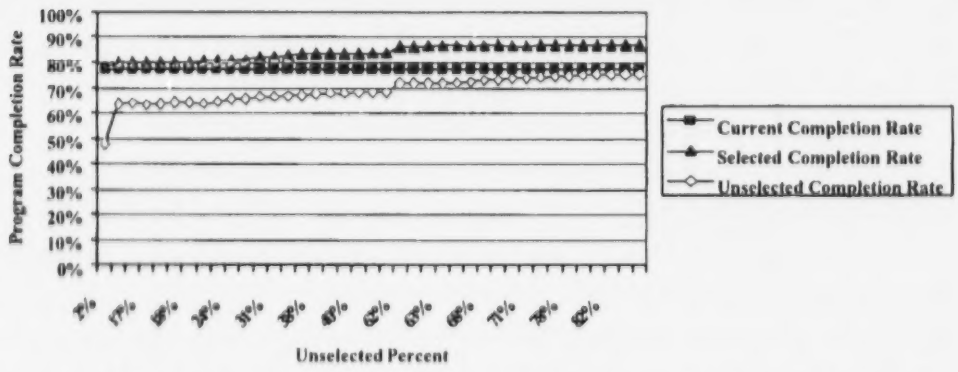
APPENDIX 2

THE COMPARISON OF THE COMPOSITE MODEL VERSUS CORE BIOLOGY ONLY

This study also surveyed the types of criteria currently used by ADN programs. Probably the most common criteria used in the selection of students into ADN programs in the California community colleges are core biology prerequisites. Students are expected to successfully complete microbiology, anatomy and physiology before starting an ADN program. In many cases, a 'C' or better is sufficient to define a successful completion. In others, a 2.3, 2.5 or higher GPA is necessary. Some practitioners believe that a composite score made up of GPA and course repetitions is overly complex and that simplicity is more appropriate for the development of acceptance models. While it is generally good to follow principles of parsimony, sometimes that is not the case. This section is designed to dispel that notion. The graph below presents the success of selected and unselected groups at various unselected percents using core biology GPA only.

The chart below replicates the earlier chart for the composite, using the core biology GPA only. Program completion rate is on the vertical axis and the unselected percent is along the horizontal axis. This represents the percent of the population unselected at a particular cut point using core biology GPA.

Selection Using Core Biology GPA Only



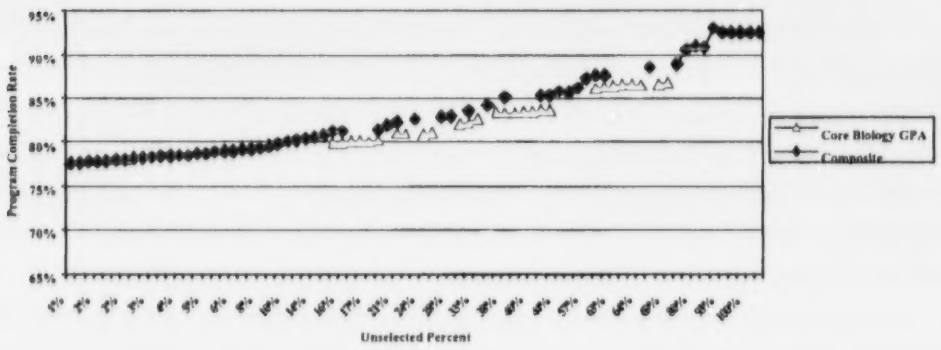
As shown, for example, a core biology GPA of 2.3 would unselect 18% of the current ADN student population. If this 18% were selected, 64% of them would complete their ADN program.

One advantage of using 'unselected percent' along the horizontal axis is that it enables comparison between the composite and core biology selection methods along a common metric. Examining the success of selected and unselected students at a similar point

allows for a direct comparison of the ability of the variables to predict program completion.

The graph below compares the program completion rates of selected students using the composite versus core biology GPA only.

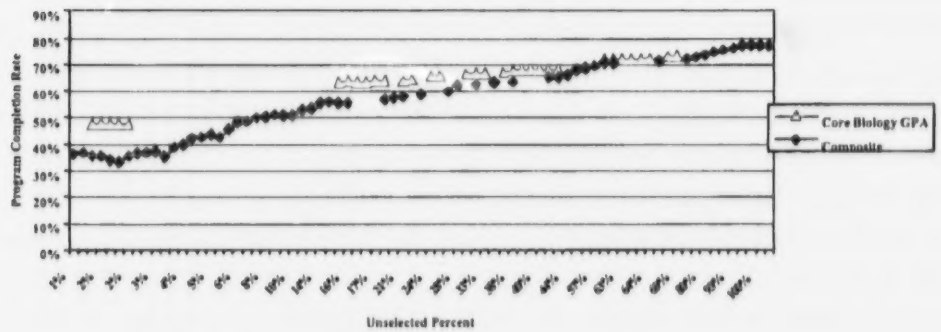
Core Biology GPA and the Composite Compared



This graph is important because at virtually all points, students selected by the composite are more successful than students selected by the use of the core biology GPA alone. In the range where 18% of the population is unselected, 80% of students selected with core biology GPA only are successful versus 82% of students selected with the composite.

Moreover, as with the previous analysis, it is important to analyze the program completion rates of unselected students.

Core Biology GPA and the Composite Compared
The Program Completion Rate of Unselected Students



The graph above presents the success of unselected students. At the points where selection might take place (i.e., 20% unselected), 57% of students unselected with the composite were successful versus 64% of students unselected with core biology GPA only. Students unselected by the composite were 7% less successful than those students unselected by core biology only.

Conclusion

There can be no question given this data that the composite prediction model is better at differentiating between successful and unsuccessful students than is core biology GPA alone. If, as was asserted earlier, good selection devices are those that provide maximal differentiation in the lines that represent selected and unselected students, then the composite outperforms core biology. Selected students at all points are more successful and unselected students are less successful with the composite than with core biology GPA alone.

APPENDIX 3

PARTICIPATING COLLEGES

Cabrillo College

City College of San Francisco

College of The Canyons

Contra Costa College

Cuesta College

Fresno City College

Glendale Community College

Grossmont College

Hartnell College

Long Beach City College

Los Angeles Pierce College

Monterey Peninsula College

Mt. San Antonio College

Napa Valley College

Sacramento City College

San Diego City College

Sierra College

Solano Community College

Southwestern College

Ventura College

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